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PROPOSED MODIFICATIONS FOR A MAGNETIC REFERENCE POINT EXTENSOMETER SYSTEM

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OCTOBER 1982

12 pp

ENERGY RESEARCH PROGRAM

COAL RESEARCH LABORATORIES

SYDNEY, NOVA SCOTIA

DIVISION REPORT ERP/CRL 82-12(R)

PROPOSED MODIFICATIONS FOR A MAGNETIC REFERENCE POINT EXTENSOMETER SYSTEM

by

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SUMMARY

A Magnetic Reference Point Extensometer (MRPE) is described and examples of operational use given. Shortcomings of the current system are described and modifications suggested which would increase the applicability and effectiveness of the instrument.

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MODIFICATIONS PROPOSÉES POUR UN EXTENSOMÈTRE À POINT DE RÉFÉRENCE MAGNÉTIQUE

par

Peter Cain*

SOMMAIRE

On décrit ici un extensomètre à point de référence magnétique (EPRM) en donnant des exemples de ses usages opérationnels. On souligne les lacunes du présent système ainsi que les modifications suggérées pour augmenter l'efficacité de l'instrument et élargir ses applications.

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CONTENTS

	Page
SUMMARY	i
SOMMAIRE	ii
INTRODUCTION	1
THE MAGNETIC REFERENCE POINT EXTENSOMETER	1
Borehole Equipment	2
Sensing Rods	2
Scanning Arrangements	2
Data Reduction	2
OPERATIONAL EXPERIENCE	3
PROPOSED MODIFICATIONS	3
CONCLUSIONS	4
REFERENCES	5

FIGURES

No.		
1.	A diagrammatic view of the Magnetic Reference Point Extensometer	6
2.	Typical results from a gateroad installation of the MRPE	7
3.	MRPE proposed modified system	8

INTRODUCTION

There are many techniques available for the determination of the behaviour of strata around underground openings in hard rock, but similar investigations in coal mines require extensometer systems to meet special requirements.

These are mainly concerned with the intrinsic safety of the equipment. Aluminium parts are generally prohibited and special electrical conditions must be met. In addition large movements of the strata are common, which not only require an extensometer system to operate during and after them but which also, because of the effect such deformation has on roadway dimensions, preclude the extension of the instrument into the roadway. This is also made more difficult by the need to use most roadways for transportation of men or materials.

An extensometer acceptable for widespread use in coal mines is described in this report.

The advantages of this system are that it is easy and inexpensive to install, it can accommodate large numbers of reference points in a hole (up to 40 are currently installed in a 10 m hole), and it has no equipment left outside the mouth of the hole. In addition, it may also be used on coalfaces, as the reference points are disposable and the borehole equipment easily cut by the coal-winning machine. As with any other instrument, certain disadvantages have become apparent after continued use and these are described. Modifications are proposed which, if developed, will make the MRPE a more acceptable system and hence more widely used in coal mines.

THE MAGNETIC REFERENCE POINT EXTENSOMETER

The principle of the Magnetic Reference Point Extensometer was described by Smart (1) and developed by a succession of researchers at the Strata Mechanics Research Group (SMRG) Department of Mineral Exploitation, University College, Cardiff, U.K. (2,3). Its current form was developed jointly by SMRG and Kenure Developments Ltd. of Camberly, Surrey, U.K. who now manufacture the instrument. It is currently being used in British coalfields by SMRG, and evaluated for use in South African gold mines by the South African Chamber of Mines.

The system consists of four parts:

1) Borehole equipment
2) Sensing rods
3) Scanning arrangements
4) Data reduction

A diagrammatic representation of the system is shown in Fig. 1 and the separate parts described below.

BOREHOLE EQUIPMENT

The MRPE reference points are ceramic magnets mounted on circular spring clips in a borehole. The reference points are mounted on an access pipe prior to installation in the hole. The access pipe or pipes are inserted into the borehole in sequence and the clips detached from the access tube by withdrawing a draw-wire. The springiness of the clip then secures them to the hole although epoxy resin is also used to bond them to the rock. Subsequent movement of the strata alters the relative positions of the reference points, which are then detected using the sensing rods.

SENSING RODS

The sensing rods are high density plastic rods with bayonet connections between them. A slot is milled down one side of each rod to house a plastic tube full of fine iron filings. The rods are assembled to the full length of the hole with the sensing tube uppermost and then rotated through 360°. This imprints the position of the magnets on the sensing medium. The rods are then withdrawn and returned to the laboratory.

SCANNING ARRANGEMENTS

In the laboratory the rods are scanned on a stationary bed by a moving detector head. Electrical output from the detector head alters as magnetised filings are traversed and this signal, together with that from a shaft encoder mounted on the drive wheel of the detector head chassis, is passed to a minicomputer which calculates the results.

DATA REDUCTION

Signals from the scanning system are fed into the minicomputer which calculates the location of the reference points and distances between each

reference point. Results from subsequent runs are plotted as graphs, an example of which is given in the following section.

OPERATIONAL EXPERIENCE

The MRPE has been used with success in British coal mines for several years and has been instrumental in the understanding of yield zone formation and strata deformation in gateroads and on coalfaces.

Typical results showing lateral extrusion of the coal into a rectangular gateroad (Taff Merthyr Colliery, NCB South Wales Area, B20's Tailgate) are shown in Fig. 2. The development of the yield zone is clearly portrayed despite some irregularities.

In the author's experience with the MRPE, two major disadvantages became apparent. The greatest drawback was the bulk and weight of the sensing rods. It was just possible for one worker to carry enough rods to monitor two 10 m holes, as well as other instrumentation, on each underground visit. To carry a complete set of rods for each run in every hole of a more extensive gateroad or room and pillar investigation, or a coalface investigation where each instrument hole would ideally be monitored four or five times during each traverse of the cutting machine, would be impractical.

The other disadvantage was associated with the manufacture of the sensing tubes. This was a time consuming, laborious activity due to the difficulty of compacting the iron filings into the plastic tube. Recently, a suitable magnetic tape has been found to replace the sensing tubes and this has led to the proposals outlined below.

PROPOSED MODIFICATIONS

In the light of the operational drawbacks outlined above, the following modifications to the magnetic sensing rods and the laboratory scanning equipment are proposed.

Instead of an integral sensing medium, each rod will be constructed as shown in Fig. 3a. The lead rod will have provision for the connection of a rounded end. Connections between rods will be by the present method, i.e., bayonet style retained by studs. The major difference between the current and proposed rods is that the milled slot in the latter will be wider and shallower than that in the former in order to accept the sensing medium.

The sensing medium in the new rods will be a high density, highly responsive magnetic tape (a suitable tape is currently being tested on conventional rods in South Wales by SMRG, Cardiff) mounted on and bonded to a metal or plastic tape. The resulting composite will be coiled and spring loaded inside a cassette in a similar manner to that used in the construction of pocket tape measures (Fig. 3b). The tape will be secured into the top of the lead rod by the rounded end (Fig. 3a) and extended along the milled slot in the rods as they are assembled in the hole. Small spring clips will be incorporated on the rods to secure the tape. The cassette will then attach to the end of the last rod (Fig. 3c), the external spring tensioning the tape.

On completion of scanning the hole, the rods would be broken down, the recorded tape being rewound in the cassette by the spring.

Current reading apparatus could be used to scan the tapes with only limited modification, although ultimately the development of an accurate, high-speed tape recorder type monitor is envisaged, reducing the bulk of the laboratory apparatus and the time taken to convert the data.

CONCLUSIONS

The MRPE has proved itself in a demanding environment. Despite operational disadvantages, it has furthered the understanding of yield zone formation in coal mine gateroads and faces.

However, a clear case for modification can be made out, especially if its underground use is to be increased. The modifications can be summarized as:

1) Replacement of the current sensing medium by a cassetted tape

2) Re-design of the current reading instrumentation.

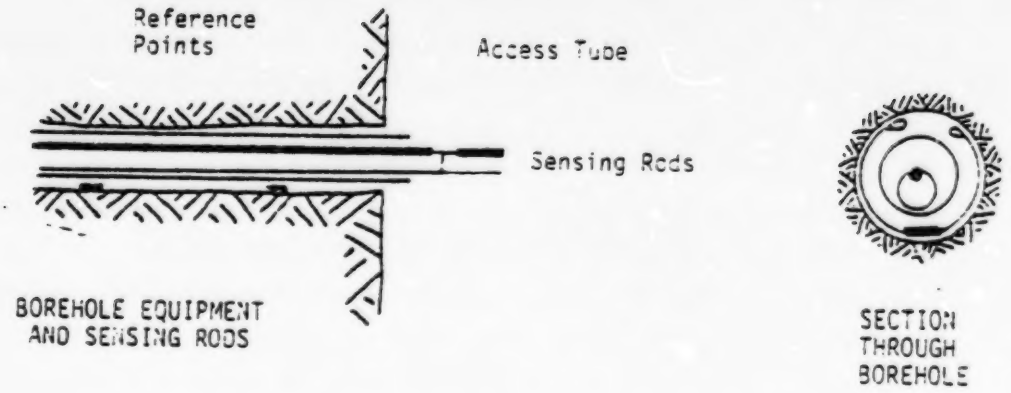
Successful implementation at these stages will greatly increase the applicability and effectiveness of the MRPE system.

REFERENCES

1. Smart, B.G.D.S. Ph.D. Thesis; University of Strathclyde, Scotland.

2. Aziz, N. Ph.D. Thesis; University of Wales; 1978.

3. Nicholas, P.K. Ph.D. Thesis; University of Wales; 1981.



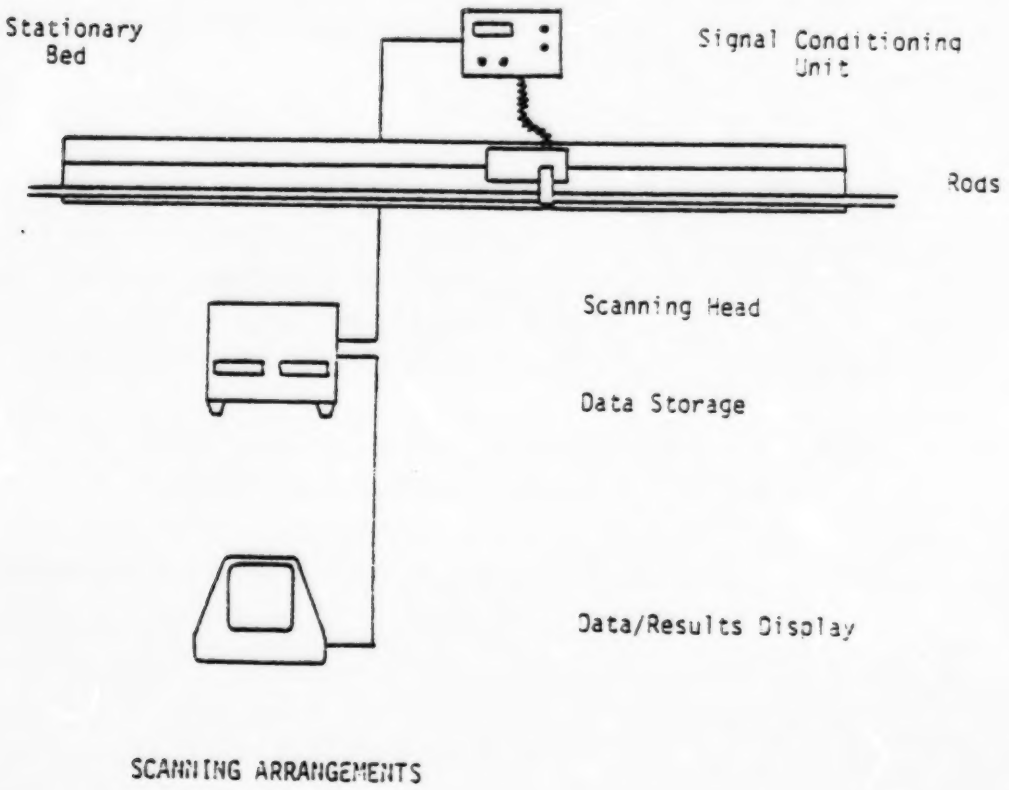
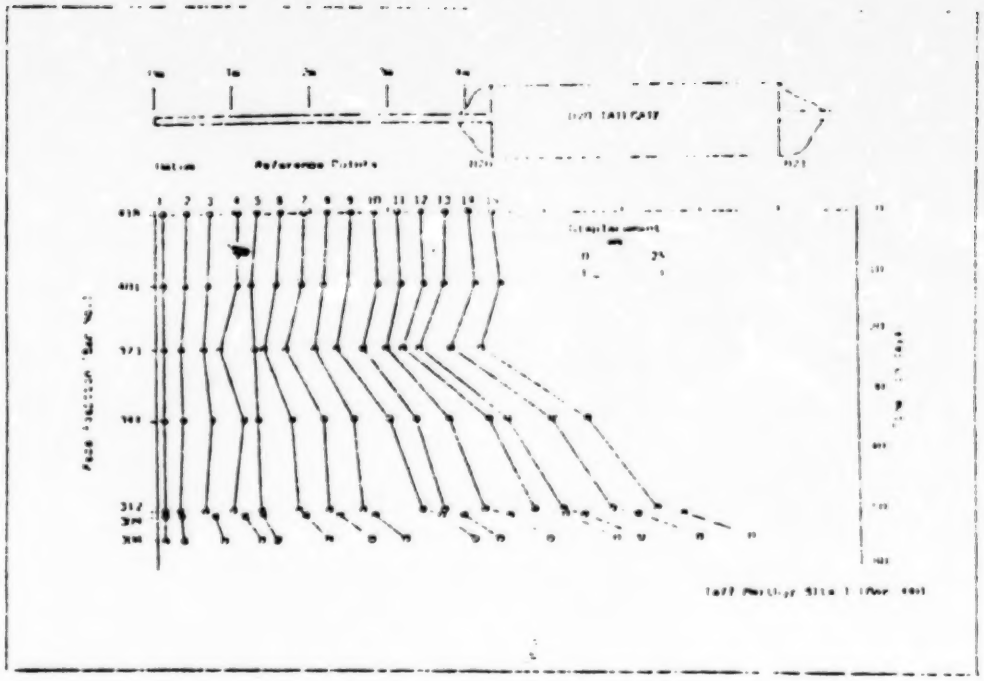
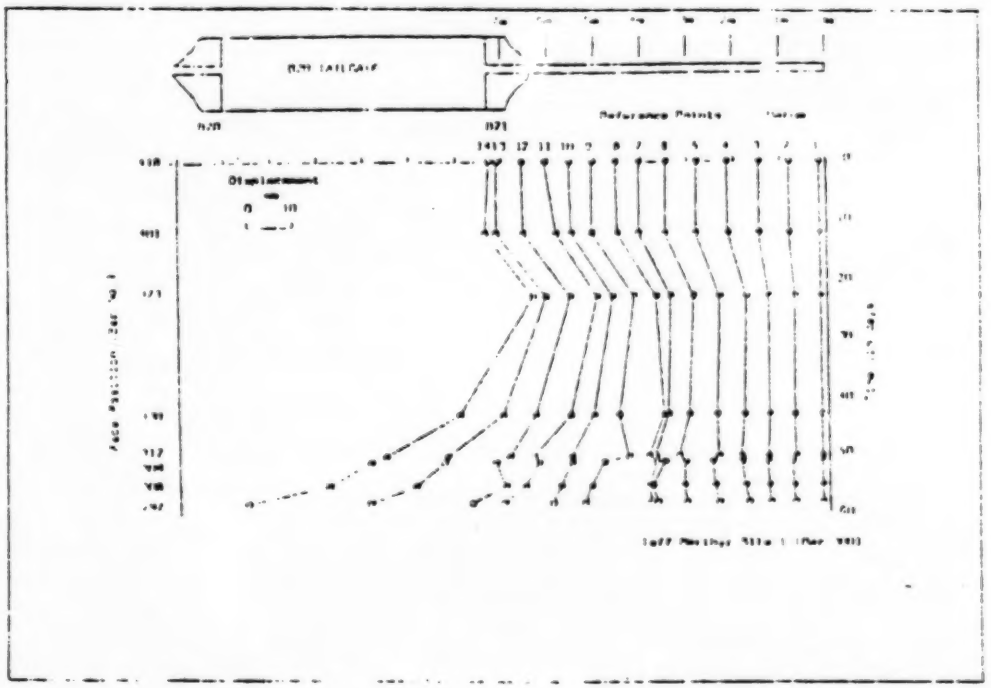


Fig. 1 - A diagrammatic view of the Magnetic Reference Point Extensometer.

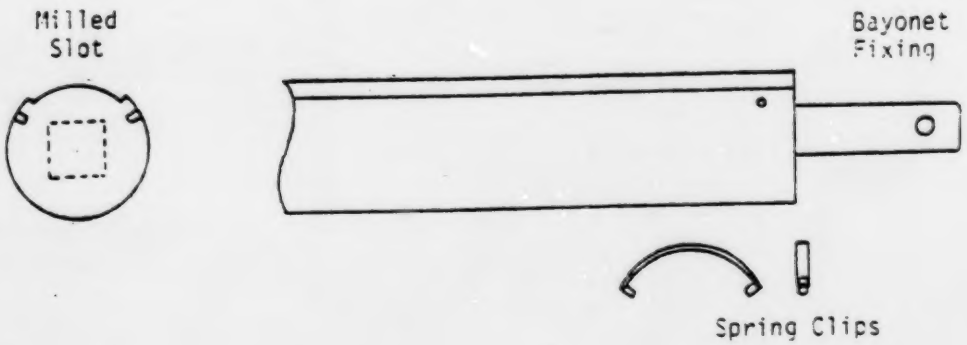


(a) Face Side

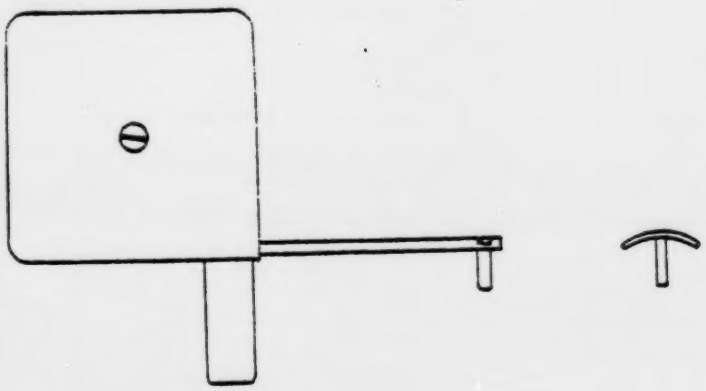


(b) Rib Side

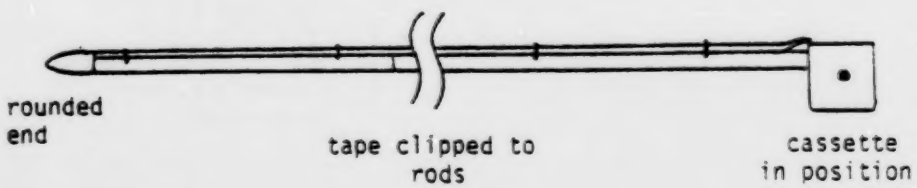
Fig. 2 - Typical results from a gateroad installation of the MRPE (Strata Mechanics Research Group, Univ. Wales, Cardiff).



a) Rod Construction



b) Tape Cassette



c) Complete Rod Assembly

Fig. 3 - MRPE proposed modified system.